TRAFFIC ENGINEERING DIVISION

MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION

Policy/Procedure Guideline

SECTION 4: Traffic Signals

SUBJECT 4.2: Traffic Signal Timing

EFFECTIVE DATE: June 1, 1995

PARAGRAPH: 1. Purpose
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1. PURPOSE:

To set forth the procedures for calculating traffic signal timing at an isolated intersection so that it provides for safe and efficient vehicular and pedestrian traffic flow.

2. DESCRIPTION:

The procedures for calculating Traffic Signal Timing

a. Data Collection

1. Geometrics including road widths.
2. Posted speed limits.
3. ADT counts & turning movement counts.
4. Review of conditions for special pedestrian and bicycle timing needs.

b. Calculation & Compilation of Given Variables

1. Determine the cross street width (W) for each phase using signal design plans. (face of curb to face of curb)

2. Convert posted speed limit into feet per second

V_{fps} = 1.47 Vmph

3. Use the following nationally accepted industry standards:(See attachments for details)

   Vehicle Gap/Passage Time (P)= 2.0-5.0 secs range

   Deceleration Rate (a)= 10.0 ft/sec^2
   (recommended by The Traffic Control Devices Handbook)

   Vehicle length (L)= 20.0 ft
   (recommended average car length by AASHTO)

   Reaction Time (t)= 1.0 sec
   (perception-reaction time of motorists as recommended by The Traffic Control Devices Handbook)

c. Clearance Intervals (CI): See Exhibit B.

1. For Through movements

   Use formula: $CI = t + \frac{V}{2a + 64.4g} + \frac{W+L}{V}$

   See Exhibit 'D' for a detailed explanation of this formula. This is also known as the Phase Change Interval which is the Yellow indication plus the All Red indication. The All Red indication is the third term of the formula. The yellow indication is the sum of the first and second terms of the formula. The value (g) represents grade (+ or -), since grade variations are usually negligible in Maricopa County it is assumed to be zero in most cases. (Values are rounded to nearest tenth of a second) See Exhibit B.

2. For Left-Turn Arrows use a 3.0 seconds yellow clearance. When a longer clearance is considered necessary due to unusual geometry the formula above will be used using the following variables: (See Exhibit B)

W = The perimeter of the turning movement made by vehicles (refer to exhibit 'E').
V = 15-20mph

d. Calculate the Pedestrian Clearance Interval (PedCI)
Use formula: (PedCI) = (W÷4) - CI

This is the flashing "Don't Walk" indication. Values are rounded up to the nearest whole second. Maricopa County's "Walk" indication is typically 7.0 secs. (recommended range is from 4-7 seconds by The Manual of Uniform Traffic Control Devices) W=the distance from face of curb to face of curb, Assumed an 85th percentile walking speed of a average adult is 4 fps. Slower walking speeds may be used when determined appropriate for specific areas. (A minimum of 2.5 fps) See Exhibit B.

e. Use State-of-the-Art software (ie: SIGNAL85©, HIGHWAY CAPACITY SOFTWARE©, ETC.) to calculate minimum and maximum green intervals and the level-of-service. In addition to the afforementioned data the software, SIGNAL85©, can provide other useful information such as; suggested cycle lengths, optimized phasing sequences, capacity analysis, saturation flow rates, and delay analysis. See Exhibit B.

f. At intersections with established bike routes, a check shall be made to ensure that the minimum green time plus the yellow and red intervals provide sufficient total time for bicyclists to cross from a standing start. The yellow plus red time intervals should also be reviewed for adequacy for bicyclists crossing from a rolling start.

g. Have second Traffic Engineering person independently check all calculations.

h. Have timings approved by Design Section Coordinator.

i. Provide new timing to field crews for installation. Timing should be run on a controller in-house before installation at intersection.

j. Field check effectiveness of timings at AM and PM peak hours as well as off peak hours following signal turn-on.

k. If the Traffic Engineer makes a timing change it should not be changed prior to discussion with the County Traffic Engineer or his designated representative.

3. EXHIBITS:

a. Traffic Signal Timing Sheet.

b. Quick Reference Sheet - Timing Variables.

c. Signal Meeting Minutes 8/24/94.

d. Excerpt from Traffic Engineering, by William R. McShane & Roger P. Roess, Polytechnic University, 1990, Chapter 20, Basic Principles of Intersection Signalization, p.390.

e. Diagram for measurement of a left turn movement for clearance interval formula.

4. BACKGROUND:

The functional objective of signal timing is to alternate the right of way among the various phases in such a way as to:

- Provide for the orderly movement of traffic
- Minimize average delay to vehicles and pedestrians
- Reduce potential for accident producing conflicts
- Maximize capacity for each intersection approach

Unfortunately these desirable attributes are not always compatible. Accordingly, it is necessary to exercise engineering judgement to achieve the best possible compromise among these objectives. The following can be used as guiding principles:

- A minimum number of phases
- Short cycle lengths
- Green intervals proportional to the number of vehicles

per lane
- Phase Change intervals that allow drivers to stop or clear intersection safely
- Efficient operation requires field surveillance and adjustment

(The preceding information was paraphrased from reference material listed at the end of this policy)

5. AUTHORIZATION:

a. 1989 Transportation Laws of Arizona, Section 28-643. Local traffic-control devices, Page 165.

> ***28-643. Local Traffic-control devices.***
> *Local authorities in their respective jurisdictions shall place and maintain such traffic-control devices upon highways under their jurisdiction as they deem necessary to indicate and to carry out the provisions of this chapter or local traffic ordinances or to regulate, warn or guide traffic. All traffic-control devices erected shall conform to the state manual and specifications.*

6. REFERENCES:

a. The Manual of Traffic Signal Design
The Institute of Traffic Engineers, 1991
b. The Traffic Engineering Handbook
The Institute of Traffic Engineers, 1992
c. The Traffic Control Devices Handbook
The Federal Highway Administration, 1983
d. The Transportation and Traffic Engineering Handbook
The Institute of Traffic Engineers, 1982
e. The Highway Capacity Manual
The Transportation Research Board, 1985
f. The Manual Of Uniform Traffic Control Devices
The Federal Highway Administration, 1988
g. Traffic Signal Workshop-Actuated Control Text
Northwestern University Traffic Institute, 1993
h. Signal Timing Improvement Practices, NCHRP Synthesis 172
The Transportation Research Board, 1992
i. Traffic Engineering
by William R. McShane & Roger P. Roess,
Polytechnic University, 1990

7. ATTACHMENTS:

Non-applicable.

Approved: _____

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County Traffic Engineer